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LECTURE - 13

Atomic structure

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Orbital Angular momentum

$C_{SD} = 28$

Orbital angular moment $(L) = \sqrt{l(l+1)}\,\frac{h}{2\pi} = \sqrt{l(l+1)}\,\hbar$

where $= \hbar = \frac{h}{2\pi}$

Ex → $2p \rightarrow L = \sqrt{l(l+1)}\,\frac{h}{2\pi}$

$l = 1$

$= \sqrt{1 \times 2}\,\frac{h}{2\pi} = \sqrt{2}\,\frac{h}{2\pi}$ or $\frac{h}{\sqrt{2}\pi}$

Ex = $3d \rightarrow L = \sqrt{l(l+1)}\,\frac{h}{2\pi} = \sqrt{2 \times 3} = \sqrt{6}\,\frac{h}{2\pi}$

$d \rightarrow l = 2$

51. For a d-electron the orbital angular momentum is (1997, 1M)

$l = 2$

a. $\sqrt{6}\left(\frac{h}{2\pi}\right)$

b. $\sqrt{2}\left(\frac{h}{2\pi}\right)$

c. $\left(\frac{h}{2\pi}\right)$

d. $2\left(\frac{h}{2\pi}\right)$

$$L = \sqrt{l(l+1)}\,\frac{h}{2\pi}$$

$$= \sqrt{2\times 3}\,\frac{h}{2\pi} = \sqrt{6}\,\frac{h}{2\pi}$$

54. The orbital angular momentum of an electron in 2s-orbital is (1996, 1M)

$l = 0$

a. $+\frac{1}{2} \cdot \frac{h}{2\pi}$ 20 sec

b. zero ✓

c. $\frac{h}{2\pi}$

d. $\sqrt{2} \cdot \frac{h}{2\pi}$

$s \rightarrow l = 0$

$p \rightarrow l = 1$

$d \rightarrow l = 2$

$f \rightarrow l = 3$

$$L = \sqrt{l(l+1)} \frac{h}{2\pi}$$

$= \text{zero}$

Magnetic moment [redacted]

$$\mu_m = \sqrt{n(n+2)}\ \text{B.M.}$$

↳ unit (Bohr's magneton)

Where → n = No of unpaired e^- in species

↑
↓

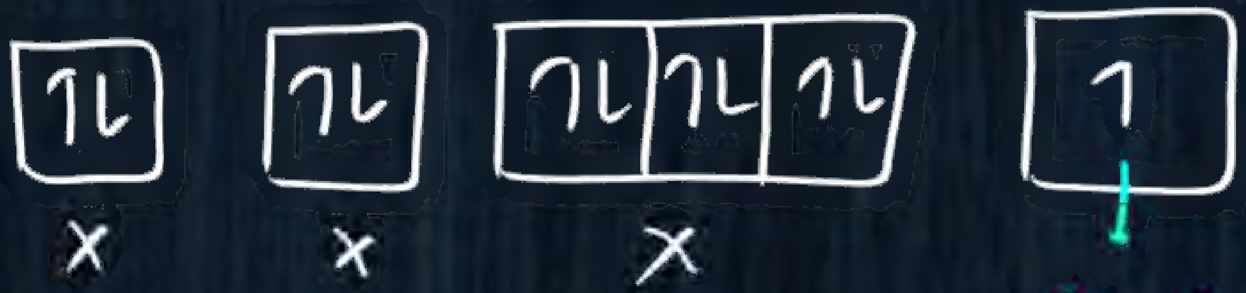
→ unpaired e^- (single e^- in orbital)

↑↓
↑↓

→ paired electron

Ex → Na-atom Ka magnetic moment $(\mu_m) = ?$

$Na \rightarrow 11 \rightarrow 1s^2, 2s^2, 2p^6, 3s^1$



$n = 1$

$$\mu_m = \sqrt{n(n+2)}\ B.M.$$

$$= \sqrt{1 \times 3}\ B.M = \underline{\sqrt{3}\ B.M.}$$

Ex → Select the species which has maximum magnetic moment (μ)

(a) He = 2 → $1s^2$ → × $n=0$

(b) Na^+ → 10 = $1s^2, 2s^2, 2p^6$ → $n=0$

(c) Ca → 20 → $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$ → $n=0$

✓ (d) Cl → 17 → $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$

($1s^2$: ×, $2s^2$: ×, $2p^6$: ×, $3s^2$: ×)

$3p^5$: [↑↓ | ↑↓ | ↑] → $n=1$

Electronic configuration of ion

$C_{SD} = 29$

Cation → step → 1 = neutral atom Ka electronic configuration karonge

step-2 → fir electron configurat^n, e^- nikalna hai

→ Note = e^- always sabse bahar wale (outer shell) se nikalte hai

Ex → Cr^{+3} (Right)

$Cr = 24 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, \underline{4s^1}, 3d^5$

$Cr^{+3} \rightarrow 4s^1 \rightarrow 4s^0$

$3d^5 \rightarrow 3d^3$

$\rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, \underline{4s^0, 3d^3}$

Ex → Cr^{+3} (Wrong)

$Cr = 24$

$Cr^{+3} = 24 - 3 = \underline{\underline{21}}$

$Cr^{+3} = 21 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, \underline{4s^2, 3d^1}$

$4s < 3d$

	4s	3d
$n =$	4	3
$l =$	0	2
$n + l =$	4	5

Q find out total $\bar{e}$ in 3d orbital of Ti^{+2}

($Ti = 22$)

(a) 1

(b) 0

✓ (c) 2

(d) 3

Sol^n $Ti \Rightarrow 22 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, \boxed{4s^2}, 3d^2$

$Ti^{+2} = 20 \Rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, \boxed{4s^0}, 3d^2$

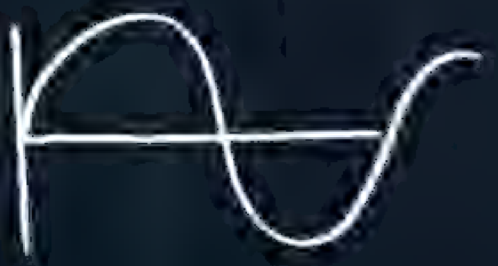
$Ti^{+2} = 22 - 2 = 20 - 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2.$

(wrong)

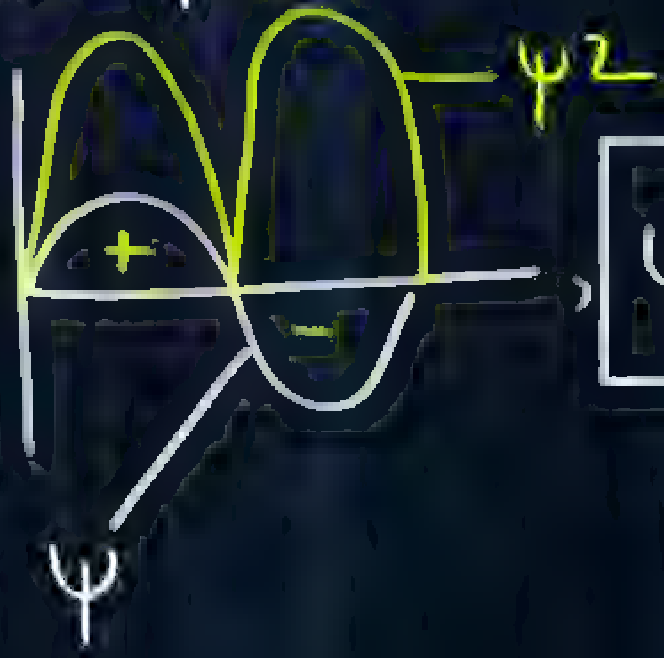
graph of orbitals

Significance of ψ and ψ^2

ψ	ψ^2
→ wave function of e^-	→ probability of finding of electron in 3D space

ψ = 

ψ = +, −ve, zero (value)

ψ^2 = 

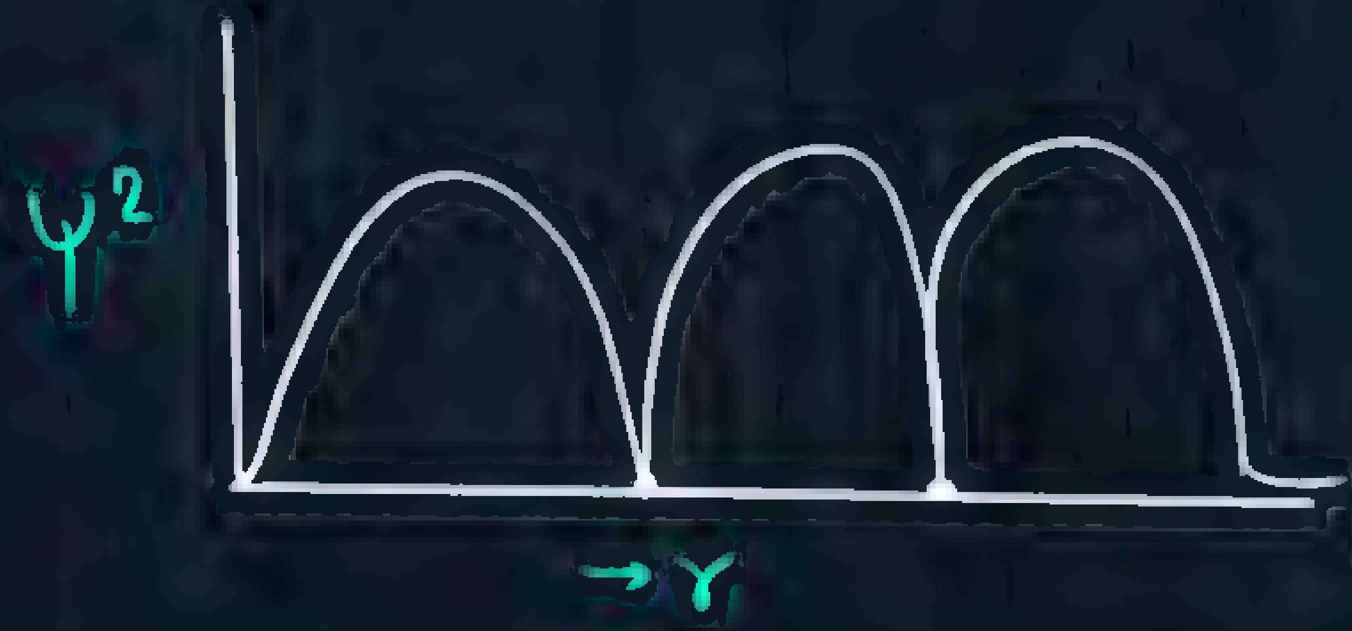
ψ^2 = 0, +ve value

$C_{SD} = 79$

S, P, d → orbital Ka graph ψ^2 Vs r , $4\pi r^2 dr$ Vs r

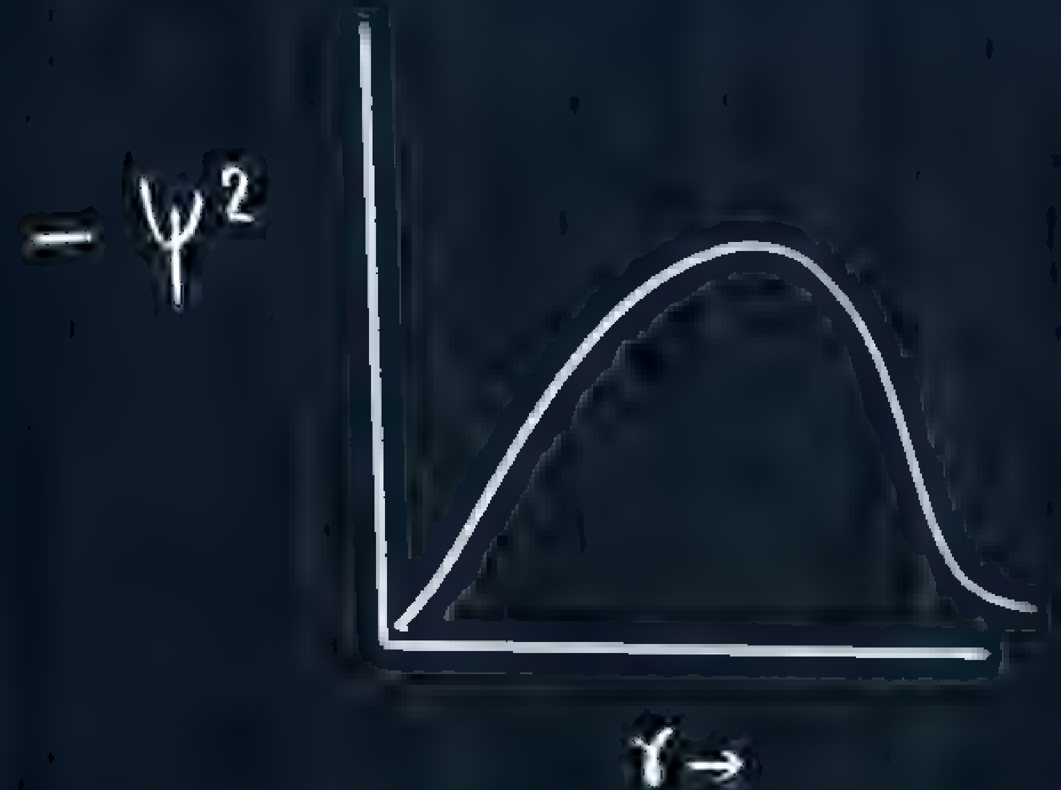
↓

probability of finding of $\bar{e}$ in very thinkness dr



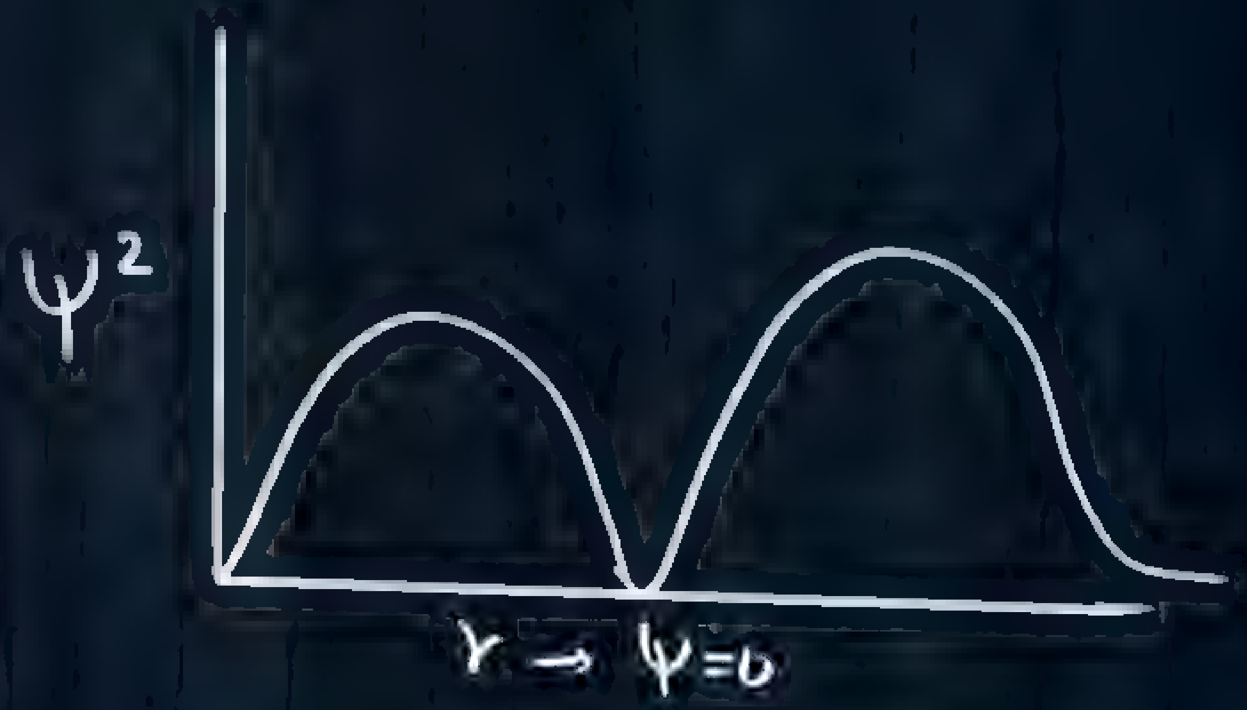
① Radial node = n − l − 1
($\psi = 0$)

2p-orbital → R node = $n-l-1 = 2-1-1 = 0$



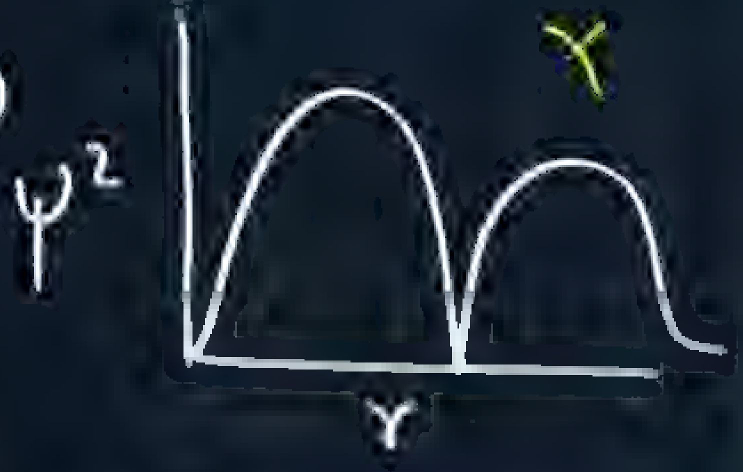
3p-orbital

R. Node = $n-l-1 = 3-1-1 = 2$ ($\psi = 0$)

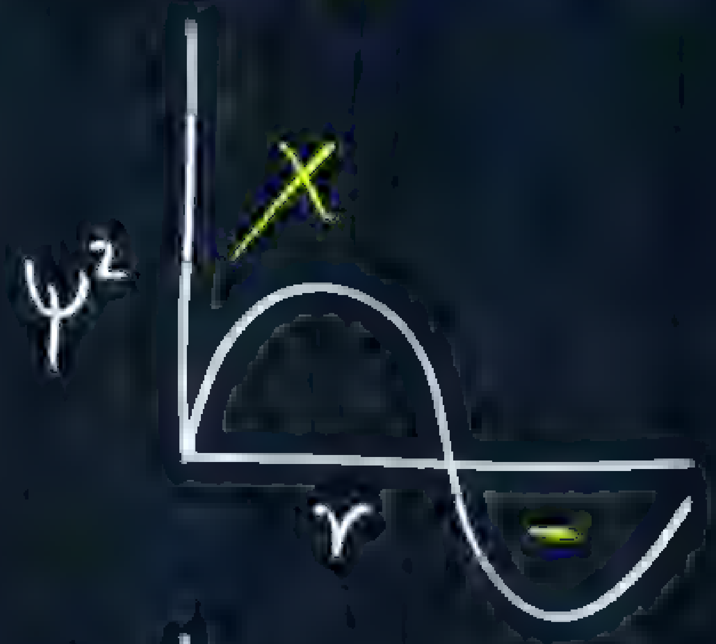


Q → select correct graph of 3d-orbital → R. Node = $n-l-1 = 3-2-1 = \underline{\underline{0}}$

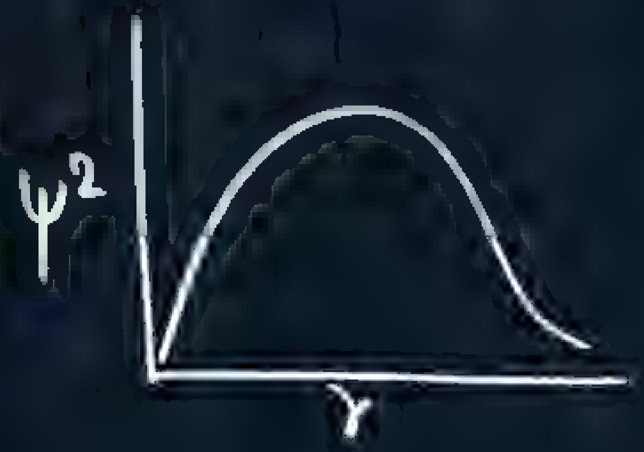
(a)



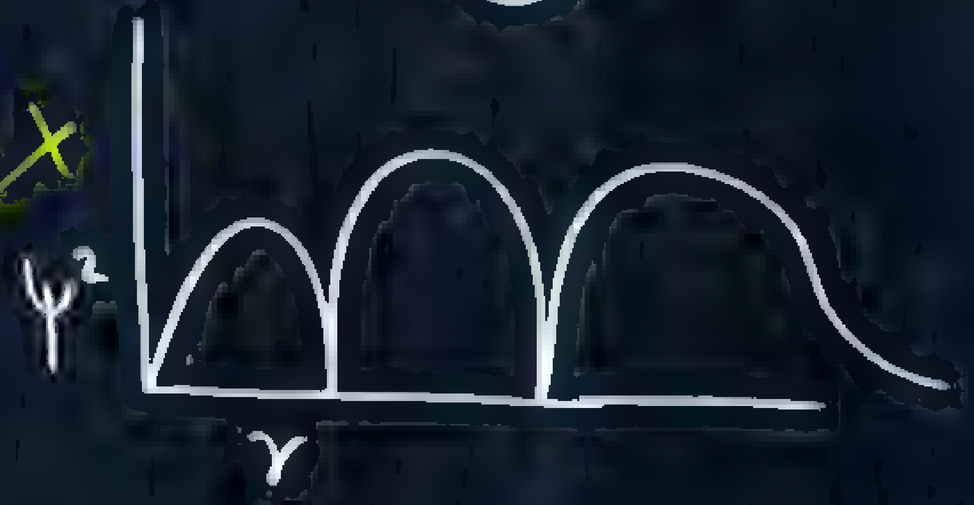
(c)



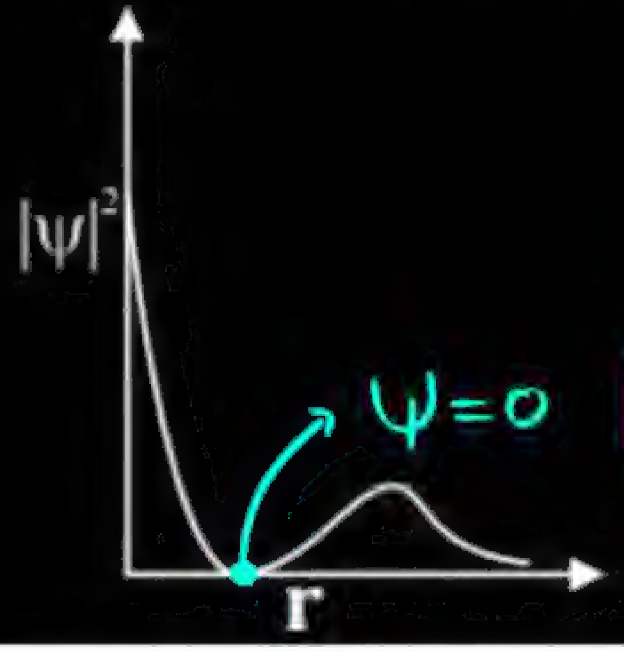
(b) ✓



(d) X



28. The graph between $|\Psi|^2$ and r (radial distance) is shown below. This represents (2019 Main, 10 April II)



a. 1s-orbital = 1-0-1=0 ×

b. 2p-orbial 2-1-1=0 ×

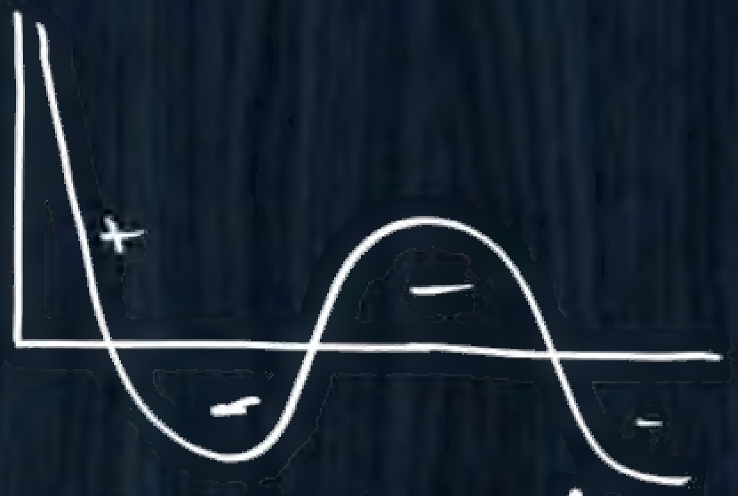
c. 3s-orbital 3-0-1=2 ×

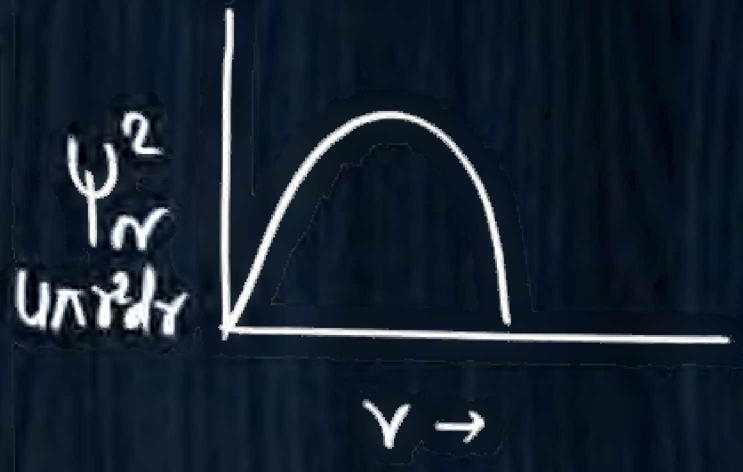
d. 2s-orbital 2-0-1=1 ✓

$C_{SD} = 30$

s-orbital

ψ Vs r →

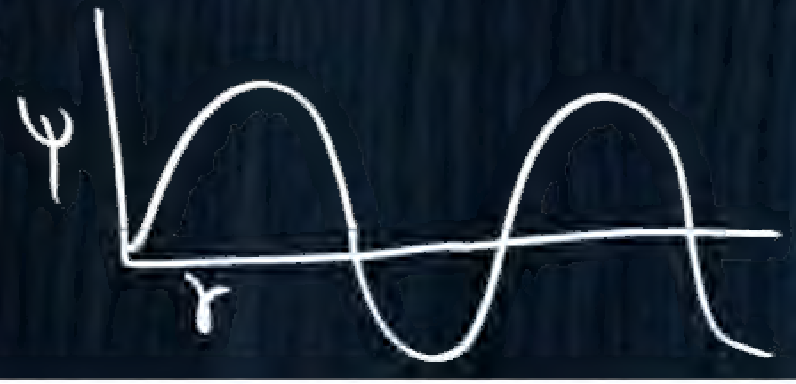




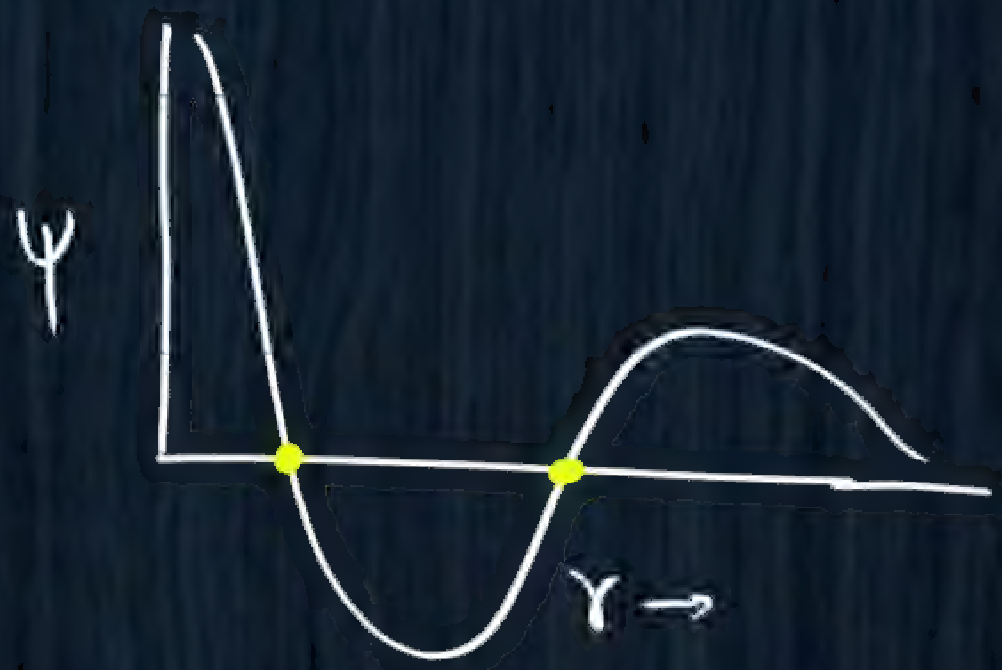
R. Node ke equal bar line (x-axis) ko graph cut karenga.

P, d-orbital

ψ Vs r



Q



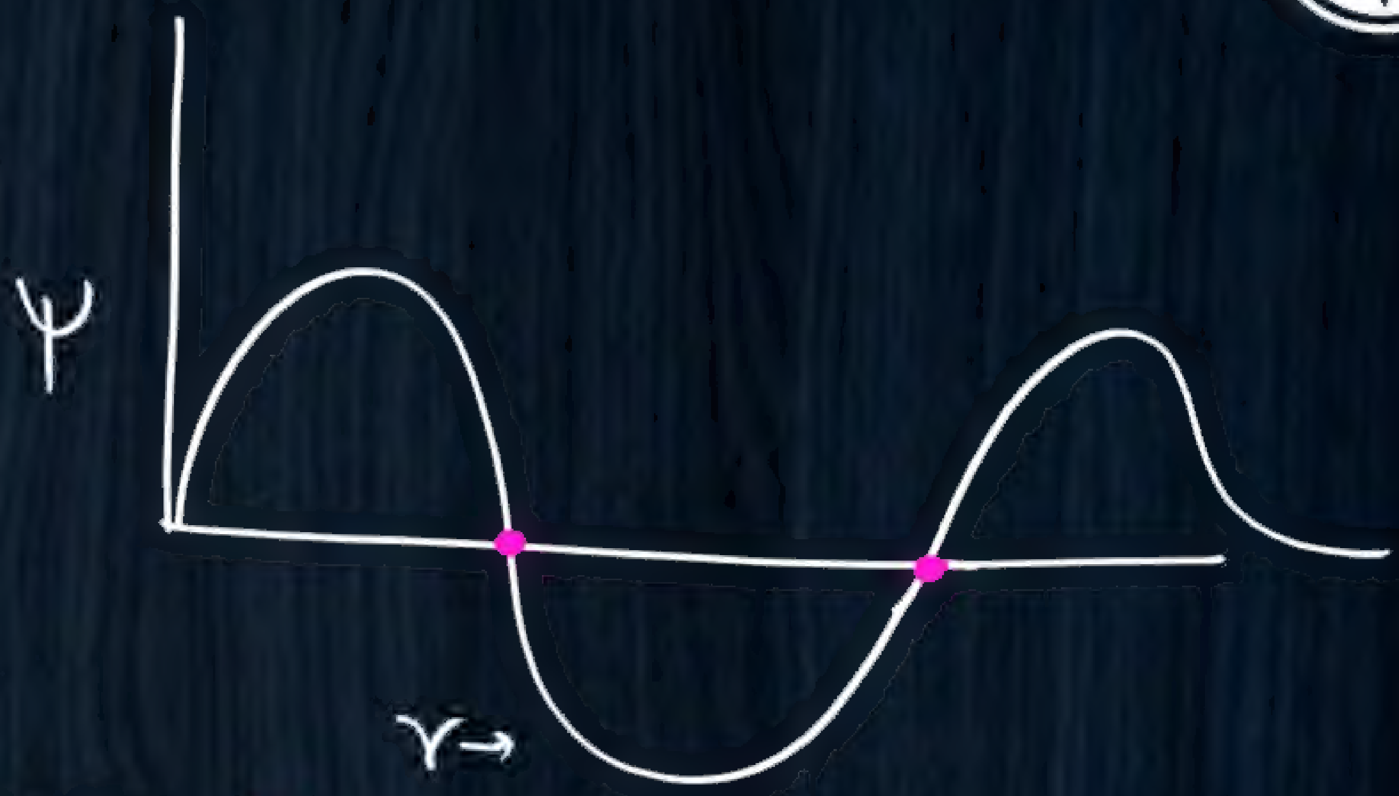
(a) 2s → R.No. = 2-0-1 = 1

✓ (b) 3s → R.No. = 3-0-1 = 2

(c) 3p ✗

(d) 3d ✗

Q



(a) 2s ✗

(b) 3s ✗

(c) 3p → 3-1-1 = 1

(d) 3d – 3-2-1 = 0

✓ (e) 4p → 4-1-1 = 2

Thank - You